

# **INDOOR AIR QUALITY ASSESSMENT**

**Dennett Elementary School  
80 Crescent Street  
Plympton, Massachusetts**



Prepared by:  
Massachusetts Department of Public Health  
Bureau of Environmental Health Assessment  
Emergency Response/Indoor Air Quality Program  
January 2004

## **Background/Introduction**

At the request of Abdu Nessralla, Plympton Board of Health, the Bureau of Environmental Health Assessment (BEHA) provided assistance and consultation regarding indoor air quality concerns at the Dennett Elementary School (DES), 80 Crescent Street, Plympton, Massachusetts. The request was prompted by concerns about mold as a result of humid weather experienced during the first three weeks of August 2003.

On September 12, 2003, a visit to conduct an indoor air quality assessment was made to this school by Michael Feeney, Director of the Emergency Response/Indoor Air Quality (ER/IAQ) program, BEHA. Following the September 2003 visit, BEHA staff had provided guidance to the Silver Lake Regional School District concerning mold remediation at the DES (MDPH, 2003) (Appendix A). This report summarizes air monitoring results and actions that may be taken to prevent a reoccurrence of microbial growth in the DES.

The DES is a one story, multi-wing structure built in 1973. The school was renovated in 2003. The school services approximately 260 students in grades K-6. At the time of the assessment, students were occupying temporary classrooms that were created through the partitioning of the gymnasium and cafeteria. Classrooms with water damage/mold growth were contained from occupied areas with polyethylene plastic and duct tape barriers (Picture 1). Air conditioning components of the heating, ventilating, and air-conditioning (HVAC) system were operating in attempts to reduce indoor relative humidity. Prior to the BEHA assessment, the school department had contracted with a consulting firm to conduct air sampling within the building.

## **Methods**

Visual observation of building components for mold and water damage was conducted. Air tests for temperature and relative humidity were taken with the TSI, Q-Trak, IAQ Monitor, Model 8551. Test results appear in Table 1.

## **Results/Discussion**

The building was evaluated on a day with an outdoor temperature of 69°F and relative humidity of 52 percent. The last recorded rainfall in the Plympton area occurred September 9, 2003 (Weather Underground, 2003), three days prior to the assessment. Indoor temperatures ranged from 69°F to 73°F, equal to or slightly above the outdoor temperature. The relative humidity in the unoccupied section of the building ranged from 53 to 55 percent. It is important to note that relative humidity measured indoors exceeded outdoor measurements by approximately 1 to 3 percent, despite indoor temperatures.

BEHA staff observed mold colonization on a variety of building materials. Non-porous surfaces [e.g., tables (Picture 2)] were coated with materials (e.g., dust) that can support microbial growth if exposed to moisture for extended periods. Porous materials sustaining water damage include gypsum wallboard (GW), ceiling tiles and pipe insulation (Pictures 3-5). Water damage/mold growth appeared to be on materials that were part of or in close proximity to chilled water components of the ventilation system (e.g. pipe insulation).

Pipe insulation that is moistened for an extended period of time can result in several problems. The exterior wrap is made of a paper material that, if not dried, can serve as a medium for mold growth. In addition, wetting of insulation can degrade its performance, resulting in increased energy costs. Condensation forms if spaces in the insulation exist or the R rating of the insulation is not sufficient. The R rating is a mathematical representation of the ability of insulation to prevent temperature transfer. If an air conditioning system has chilled water pipes with an insufficient R rating, temperature could be transferred to the surface paper, thus creating condensation. Once water wets insulation, a temperature bridge is created, which results in further wetting of insulation and enhancing mold growth.

The US Environmental Protection Agency and the American Conference of Governmental Industrial Hygienists (ACGIH) recommends that porous materials be dried with fans and heating within 24-48 hours of becoming wet (ACGIH, 1989; US EPA, 2001). If porous materials are not dried within this time frame, mold growth may occur. Water-damaged porous materials cannot be adequately cleaned to remove mold growth. The application of a mildewcide to moldy porous materials is not recommended.

Several sources of condensation appear to be responsible for repeated moistening of building materials. The primary of moisture source appears to be the condensation formed through the introduction of outside air into the building via unit ventilators (univents). When warm, moist air passes over a surface that is cooler, water condensation can collect on the surface. Over time, water droplets can form and drip. For this reason, drainage systems and pans are installed beneath HVAC cooling coils.

Condensate forming on cooling coils can drain into the pan. At the DES, PVC piping installed through the exterior wall provide univent drain pans with a means to drain directly outdoors (Pictures 6 and 7).

As previously mentioned, the indoor relative humidity measurements exceeded the outdoor measurement by 1 to 3 percent. The difference in relative humidity to temperature indicates that the operation of the univent chillers were not effective in removing moisture from the building on the day of the assessment. BEHA staff checked univent drainpipes to monitor drainage. All condensation drains were dry at the time of assessment (Picture 7). Based on these findings, operation of the univents in the chilled air mode did not appear to be reducing water vapor levels. Rather, operation of univents (even with fresh air intake louvers closed) may contribute to the introduction of moisture into the building during hot, humid weather.

As previously discussed, each univent PVC drain passes through the exterior wall. BEHA staff observed spaces around the PVC pipe that can allow moisture to be drawn through the exterior wall by univent fans (Picture 7). This contingency is likely, since the drip pans are located below the univent fans. As fans operate, the area within a univent that is between the fan and air intake vents becomes depressurized. This depressurization can draw outdoor air through unintentional spaces, such as the ones around the univent drains, into the univent cabinet. In this manner, moist, humid air can be drawn into the building

Of note was a condensation collection pump system located above the ceiling that services the library's HVAC system (Picture 8). The condensation drain pump is located on a metal support that is heavily corroded. Since neither the condensation

pump nor the metal support is insulated, the temperature of the chilled water from the HVAC system lowers the temperature of the support, making it prone to condensation generation. Once condensation collects on the support, the ceiling tile below becomes chronically moistened. If not allowed to dry, ceiling tiles can serve as a mold growth medium.

Another possible area providing for water penetration is the exterior wall along the sheltered sidewalk outside the art room. A significant seam was observed at the cement/exterior wall junction (Picture 9). This seam appears to be unsealed. Under wet weather conditions, an easterly wind can drive rain into this seam. It is usual building practice to seal this type of seam to prevent water penetration.

Lastly, BEHA staff found that exhaust vents were deactivated in the unoccupied areas of the DES. Activating the exhaust ventilation system would aid in the removal of water vapor from the building.

## **Conclusions/Recommendations**

In view of the findings at the time of the assessment, the following recommendations are made:

1. Continue with plans to remove mold-colonized materials, such as pipe insulation, ceiling tiles, and gypsum wallboard. Remediate mold contaminated building materials in a manner consistent with *Mold Remediation in Schools and Commercial Buildings* published by the US Environmental Protection Agency (US EPA) (US EPA, 2001). Copies of this document can be downloaded from the US EPA website at: [http://www.epa.gov/iaq/molds/mold\\_remediation.html](http://www.epa.gov/iaq/molds/mold_remediation.html)

2. Clean non-porous surfaces with an appropriate antimicrobial agent. Wash treated surface with soap and water to remove residues.
3. Consider consulting a building engineer to determine the effects of water damage to chilled water pipe and univent insulation. Remediate as needed.
4. Insulate the condensation pump in the ceiling of the library to prevent future condensation.
5. Seal spaces in exterior wall around condensation drains.
6. Seal seam at cement/exterior wall junction outside air room.
7. Activate exhaust ventilation system to aid in moisture removal.

## References

ACGIH. 1989. Guidelines for the Assessment of Bioaerosols in the Indoor Environment. American Conference of Governmental Industrial Hygienists, Cincinnati, OH.

MDPH. 2003. Letter to Gordon L. Noseworthy, District Superintendent from Suzanne Condon, Assistant Commissioner, Bureau of Environmental Health Assessment concerning mold remediation issues at Dennett Elementary School, Plympton, Massachusetts, Dated September 9, 2003. Massachusetts Department of Public Health, Bureau of Environmental Health Assessment, Boston, MA.

US EPA. 2001. *Mold Remediation in Schools and Commercial Buildings*. Office of Air and Radiation, Indoor Environments Division, Washington, DC. EPA 402-K-01-001. March 2001.

Weather Underground, The. 2003. Weather History for Plymouth, Massachusetts, September 9, 2003. <http://www.wunderground.com/history/airport/KPYM/2003/9/9/DailyHistory.html?FULLALMANAC=KBOS>



**Picture 1**



**Polyethylene Plastic and Duct Tape Barriers Erected inside Hallways**

**Picture 2**



**Table Coated with Surface Mold Colonies**

**Picture 3**



**Mold Colonized GW, Note Insulated Univent Pipes**

**Picture 4**



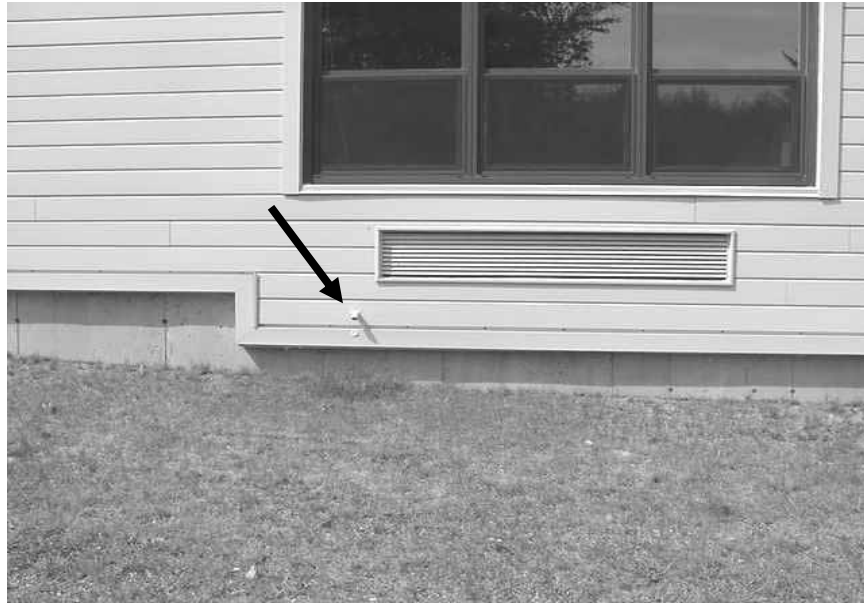
**Mold Colonized Ceiling Tiles**

**Picture 5**



**Mold Colonized Pipe Insulation**

**Picture 6**



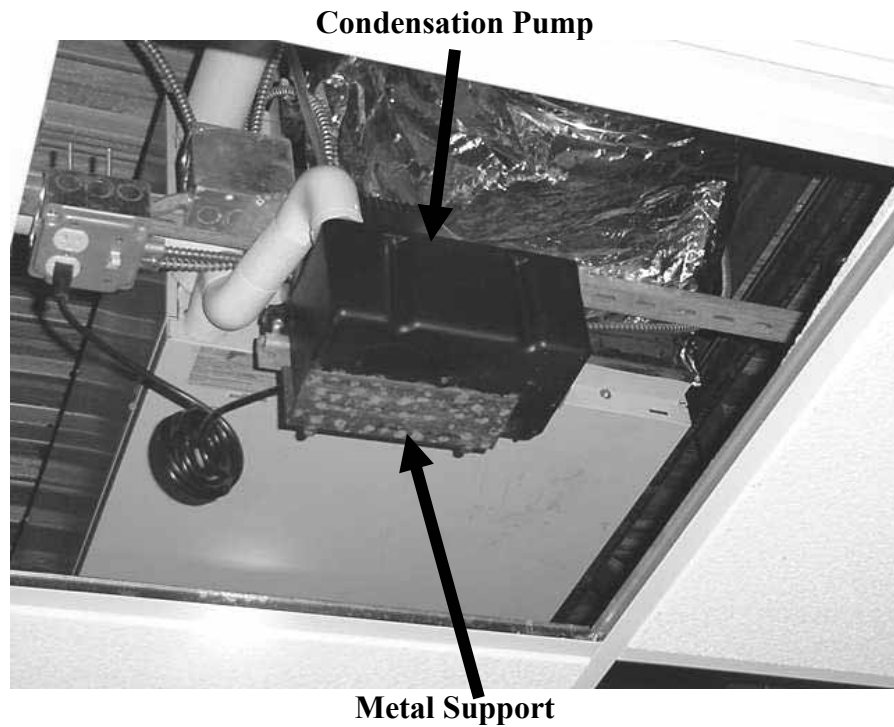
**Univent Condensation Drain**

**Picture 7**



**Condensation Drain, Note Space around PVC Pipe and Lack of Water Draining from Pipe**

**Picture 8**



**Condensation Collection Pump System Resting On Metal Support, Note Heavy Corrosion on Support**



**Picture 9**

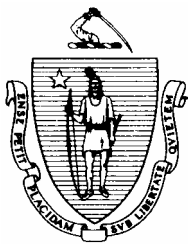


**The Cement/Exterior Wall Junction outside Art Room**

**TABLE 1**

**Indoor Air and Temperature Test Results\***  
**Dennett Elementary School, Plympton, MA**  
**August 22, 2003**

<b>Location</b>	<b>Temp (°F)</b>	<b>Relative Humidity (%)</b>	<b>Univent Operating</b>	<b>Exhaust Vent Operating</b>	<b>Remarks</b>
Outdoors	69	52			
Art Room	70	53	Yes	Off	Water damaged ceiling tiles and gypsum wallboard
Music room	69	54	Yes	Off	Water damaged ceiling tiles and gypsum wallboard
Kindergarten	70	55	Yes	Off	Water damaged ceiling tiles and gypsum wallboard Mold contaminated table
Media Center	69	52	Yes	Off	Water damaged ceiling tiles
14	69	53	Yes	Off	Water damaged insulation
13	69	54	Yes	Off	Water damaged insulation
12	73	54	Yes	Off	
9	72	51	Yes	Off	
8	69	53	Yes	Off	
6	69	54	Yes	Off	Water damaged gypsum wallboard
4	70	54	Yes	Off	Water damaged gypsum wallboard
2	70	54	Yes	Off	
1	70	54	Yes	Off	
3	70	54	Yes	Off	Water damaged gypsum wallboard
5	70	54	Yes	Off	Water damaged gypsum wallboard
7	70	54	Yes	Off	Water damaged gypsum wallboard
15	70	53	Yes	Off	Water damaged ceiling tiles
16	70	53	Yes	Off	Water damaged ceiling tiles



# Appendix A

## The Commonwealth of Massachusetts

Executive Office of Health and Human Services  
Department of Public Health  
250 Washington Street, Boston, MA 02108-4619

MITT ROMNEY  
GOVERNOR

KERRY HEALEY  
LIEUTENANT GOVERNOR

RONALD PRESTON  
SECRETARY

CHRISTINE C. FERGUSON  
COMMISSIONER

September 23, 2003

Gordon L. Noseworthy, District Superintendent  
Silver Lake Regional School District  
250 Pembroke Street  
Kingston, MA 02364

Dear Mr. Noseworthy:

At the request of Abdu Nessralla, Plympton Board of Health, the Bureau of Environmental Health Assessment (BEHA) conducted an evaluation of the indoor air quality at the Dennett Elementary School (DES), 80 Crescent Street, Plympton, Massachusetts on September 12, 2003. Michael Feeney, Director of Emergency Response/Indoor Air Quality (ER/IAQ), BEHA, conducted this evaluation. Concerns about mold as a result of excessively humid weather during the first month of August 2003 prompted the request.

Relative humidity in excess of 70 percent can provide an environment for mold and fungal growth (ASHRAE, 1989). In the experience of BEHA staff, excessively humid weather can provide enough airborne water vapor to create adequate conditions for mold growth in buildings. In general, materials that are prone to mold growth can become colonized when moistened for 24-48 hours or more. Since hot, humid weather persisted in Massachusetts for more than 14 days during the month of August (The Weather Underground, 2003), materials in a large number of schools and buildings were moistened for an extended period of time. At the DES moistened materials were not dried with mechanical aids within a 24-48 hour period (e.g. fans, dehumidifiers, air-conditioning) and as a result, mold growth occurred.

During the course of the BEHA assessment, ceiling tiles were examined. Visible mold colonies were observed on gypsum wallboard (GW), pipe insulation and ceiling tiles in a number of classrooms. The areas with visible mold colonization were adjacent to components of the heating, ventilating and air-conditioning (HVAC) system (e.g. GW that formed pipe chase ways) or were beneath areas that had experienced leaks from the sprinkler system, as related by school personnel.

The materials listed in Table 1 were noted as either colonized with mold or had materials that were likely in contact with mold spores. The majority of materials in the building that were affected appeared to be building components (e.g. ceiling tiles, pipe wrap and GW) that require replacement. Other materials seen in the building (e.g. non-GW walls, floors and fixtures) are non-porous surfaces constructed of materials that are not likely to be colonized by mold. Rather, these non-porous surfaces were coated with materials (e.g. dust) that can support microbial growth if exposed to moisture for extended periods of time. Therefore, cleaning of non-porous surfaces and removal of mold-colonized objects should remedy the mold contamination problem within the DES.

Please note that a change in weather conditions during the early Fall (i.e. dryer and cooler conditions) will help to prevent further mold colonization in this building. Deactivation of the air chilling capacity of the HVAC system is advised, once hot, humid weather has ceased. This will stop further condensation generation. Once deactivated, replacement of mold contaminated pipe insulation is recommended.

It is worthy to note that no visible mold colonization or musty odors in stored materials and books was observed. A decision should be made, however, concerning the storage of certain other porous materials contaminated with mold. Boxes, documents, books and other materials can become sources of mold, spores and associated odors if moistened over extended periods of time. In this case, dehumidification and ventilation alone cannot serve to reduce or eliminate mold growth in these materials. As an initial step, options concerning the preservation of materials stored in classrooms should be considered. In some cases, surface mold on books can be removed using a vacuum equipped with a high efficiency particulate arrestance filter (Patkus-Lindbloom, 2003; USEPA, 2001). Porous materials that are judged not worthy of preservation, restoration or transfer to another media (e.g. microfiche or computer scanning) should be discarded. When materials are to be preserved, restored or otherwise handled, an evaluation should be conducted by a professional book/records conservator. This process can be rather expensive and may be considered for conservation of irreplaceable documents that are colonized with mold. Due to the cost of records conservation, disposal or replacement of moldy materials may be the most economically feasible option.

The US Environmental Protection Agency and the American Conference of Governmental Industrial Hygienists (ACGIH) recommend that porous materials be dried with fans and heating within 24-48 hours of becoming wet (US EPA, 2001; ACGIH, 1989). If porous materials are not dried within this time frame, mold growth may occur. Water-damaged porous materials cannot be adequately cleaned to remove mold growth. The application of a mildewcide to moldy porous materials is not recommended.

In order to avoid potential mold and related spore movement during remediation, the following recommendations should be implemented in order to reduce contaminant migration into adjacent areas. These recommendations illustrate the potential of mold to impact indoor air quality.

1. Use local exhaust ventilation and isolation techniques to control remediation pollutants. The design of each system must be assessed to determine how it may be

impacted by remediation activities. Specific HVAC protection requirements pertain to the return, central filtration and supply components of the ventilation system. This may entail: shutting down systems during periods of cleaning, when possible; ensuring systems are isolated from contaminated environments; sealing ventilation openings and utilizing filters with a higher dust spot efficiency where needed (SMACNA, 1995).

2. The following precautions should be taken to avoid the re-entrainment of these materials into the HVAC system at the DES:
  - a. Deactivate univents and close all windows in the area to be cleaned. Place an industrial sized fan in an open, exterior door to provide exhaust ventilation for areas to be cleaned. Be sure to place this exhaust fan in a manner to draw airborne particles away from clean areas of the building. This will draw air through univent filters and prevent uncontrolled draw of outdoor pollutants into clean areas of the building.
  - b. Seal univent air diffusers and return vents with polyethylene plastic in the areas to be cleaned. Vents for the exhaust vent system should be sealed in a similar manner.
3. Clean surfaces that do not have visible mold colonies with a vacuum cleaner equipped with a high efficiency particle arrestance (HEPA) filter.
4. Discard porous materials that are contaminated with mold.
5. Disinfect non-porous materials (e.g. door frames, linoleum, cement, Lucite topped metal desks and chairs, wood surfaces) with an appropriate antimicrobial agent is recommended. Clean non-porous surfaces with soap and water after disinfection. As soon as this second cleaning is completed, use fans that introduce air from other clean areas or dehumidifiers to dry cleaned area.
6. Seal the doors of each classroom to be cleaned with polyethylene plastic and duct tape to prevent pollutant migration into uncontaminated areas of the building. Once cleaning is completed, remove plastic from vents in cleaned area and reactivate ventilation components (supply and exhaust). Consider creating an air lock in the hallway to reduce migration of mold contaminants to unaffected areas of the school.
7. Consult *Mold Remediation in Schools and Commercial Buildings* published by the US Environmental Protection Agency (US EPA) (US EPA, 2001) for further advice on mold remediation and measures to protect individuals conducting mold cleaning. Copies of this document can be downloaded from the US EPA website at:  
[http://www.epa.gov/iaq/molds/mold\\_remediation.html](http://www.epa.gov/iaq/molds/mold_remediation.html).

We suggest that the majority of these steps be taken on any remediation/renovation project within a public building. We would be happy to conduct additional tests at the school after the heating season begins to address any other IAQ issues or concerns. Please feel free to contact us at (617) 624-5757 if you are in need of further information or if you would like us to conduct further testing in the Fall.

Sincerely,

Suzanne K. Condon, Assistant Commissioner  
Bureau of Environmental Health Assessment

cc/ Mike Feeney, Director, Emergency Response/Indoor Air Quality  
Mary Dickerson, Principal, Dennett Elementary School  
Abdu Nessralla, Plympton Board of Health  
Senator Therese Murray  
Representative Thomas J. O'Brien

## References

ACGIH. 1989. Guidelines for the Assessment of Bioaerosols in the Indoor Environment. American Conference of Governmental Industrial Hygienists, Cincinnati, OH.

ASHRAE. 1989. Ventilation for Acceptable Indoor Air Quality. American Society of Heating, Refrigeration and Air Conditioning Engineers. ANSI/ASHRAE 62-1989

Patkus-Lindbloom, Beth. 2003. Emergency Salvage of Moldy Books and Paper. Technical Leaflet, Emergency Management. Section 3, Leaflet 9. Beth Patkus-Lindbloom, Preservation Consultant, Walpole, MA.

SMACNA. 1995. IAQ Guidelines for Occupied Buildings Under Construction. 1st ed. Sheet Metal and Air Conditioning Contractors' National Association, Inc., Chantilly, VA.

US EPA. 2001. Mold Remediation in Schools and Commercial Buildings. US Environmental Protection Agency, Office of Air and Radiation, Indoor Environments Division, Washington, DC. EPA 402-K-01-001. March 2001.

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